Creating User Experience by novel Interaction Forms: (Re)combining physical Actions and Technologies

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Abstract. Human-Machine interaction incorporates two components, a human action and a technical product. Various combinations of the human action and an interaction technology result in different interaction forms. Based on the assumption that new interaction forms could help bringing (back) User Experience to driving, an approach of decomposing and (re)combining the two basic components of an interaction is suggested in this contribution for generating new interaction forms. Within this, the importance of the user action is stressed by regarding it as partial solution opposing the technical product solution.

Keywords: Human-centered Design, Activity-centered Design, Conceptual Design, Solution Generation, User Experience, Interaction Forms

1 Introduction

Regarding automobile development of the last years, the emergence of a multitude of advanced driver assistant systems (ADAS) could be observed. The various existing systems aim at overtaking or at least at supporting the driver in the execution of the various driving tasks from controlling speed over changing lanes to parking the car. Although this trend focuses on supporting safety and comfort for driver and passengers, this development brings two consequences automotive development has to cope with today, especially in regards to User Experience (UX). On the one hand there is a confusing and unclear multitude of functionalities built-in in nowadays cars, which is hard to overview and difficult to understand in its purpose and application. On the other hand this increased number of ADAS leads to some kind of "automation" regarding the driver's task(s) as such.

As a result, the various existing functionalities of a car are often hard to use and thus are barely applied consciously by the drivers. At the same time the driver's task as such loses relevance in regards to its influence on UX while the driver's cognitive

resources are relieved and ready for alternative occupation. This resulting "cognitive space" could now be filled by other experiences related not only to driving as such but to other activities conductible while driving and not only for the driver but co-driver and passengers as well.

Regarding the technological possibilities employable for the interaction between human and car, the variety of technologies developed and applied in other product fields as communication and entertainment devices is consequently growing. For example the idea of employing freehand gestures for human-car interaction is not new, however, eventually innovative combinations of basic technologies as employed within the *wii* or the *kinect* pave the way for an automotive application. This wide field of interaction technologies delivers great freedom in defining and designing the user interaction in innovative ways. Employing new forms of interaction based on these various technologies could serve as mean to overcome the former mentioned problems and thus help bringing (back) UX to driving a car.

However, in how far a defined form of interaction is successful depends not only on the underlying input and output technologies but as well on the way these technologies are combined with a specific human action to embody the complete interaction [1]. Knowing this, exploring the various forms of interaction that could be enabled by certain technologies seems to be a favorable step before defining a concrete interaction. To support this, an approach will be presented in the following. This approach grounds on methodological design principles applied in industrial and engineering design.

On the one hand the goal of this approach is to enlarge the solution space of interaction forms based on the assumption that the interaction as such plays a major role for UX. On the other hand it focuses on the consideration of the human physical action as partial solution in the all-over user-product system as a great importance is ascribed to this action in regards to UX. Thus, the provided approach concentrates on the (human) input-side of human-machine interaction (that relates to the human action) rather than output side (which presents the human perception).

2 Background

In design, a solution process often starts by broadening the solution space. Various methods to accomplish this task exist in industrial and engineering design [2]. Especially in engineering design a lot of specific methods base on two more general design approaches, the principle of *abstraction* and *(stepwise) concretization* and the principle of *decomposition* and *(re)combination* [3]. Both of these principles can be employed in combination in a solution generation process [4].

2.1 Abstraction and (stepwise) Concretization

The principle of abstraction aims for overcoming mental barricades and opening new solutions spaces by abstracting a given product or product idea to the core problem or task it should serve for before developing concrete solutions. Thus, the

development starts by identifying the essential product functions. Based on this set of product functions a concretization process starts with the development of conceptual design solutions in form of working principles and structures. Finally, these conceptual solutions will be further concretized to concrete product solutions.

Especially in regards to the consideration of UX the discussion of abstract product functions seems to be of importance as all the functions should serve the all-over purpose of the product. Questioning not only the product functions but the product purpose itself is important when it comes to designing UX and should lead to the consideration of not only practical needs of the user but psychological ones as well [5].

2.2 Decomposition and (re)combination

The principle of decomposition aims for reducing an extensive problem or task to smaller sub problems or tasks which could then be solved or accomplished separately (e.g. by means of abstraction) before (re)combining their solutions.

Since many new and innovative solutions ground on the (re)combination of existing partial solutions with (sometimes) only a few newly developed ones, this principle represents a powerful approach in the solution finding process. Applying this principle to the generation of interaction solutions by considering the solution-contribution of the human actions led to the approach described in the following.

3 Approach

The goal of this work is to use the principles of abstraction of interactions as well as decomposition and (re)combination of partial solutions for the development of new interaction solutions. Approaches of Human-centered Design (HCD) stress the importance of the user within the system and recommend not developing a system "around" the user but a user-product system instead [6]. Furthermore, approaches of Activity-centered Design (ACD) point out the importance of the role of the human action within this user-product interaction [1]. This implies a particularity of interaction solutions that is of importance for the application of the principles of abstraction, decomposition and (re)combination. If the user and its action play such an important role within the user-product system, one could see the user as active and solution-contribution part. An existing interaction solution could thus be decomposed into the human action – in form of the specific movement of a certain body part – and the interaction technology. While the specific movements could be abstracted to more general movements in space, this decomposition leads to a collection of explicit partial solutions on both sides, action "solutions" on the human user side and technology solutions on the technical product side. To give an example, existing input forms are decomposed and abstracted. As illustrated in figure 1, these partial solutions can now be (re)combined to generate novel input forms that could positively impact UX.

			Physical human action: rotational or translational movement of…												
	Input Modality	**Input Technology**	Upper Extremity			Lower Extremity			Head				Whole Body		
			Arm	Hand	Finger	Leg	Foot	Toe	Head	Face	Mouth	Eyes	Whole Body	Upper Body	Lower Body
Interaction Technologies	Touchbased Gestures (2D)	Capacitive Touchscreen	X		O	X			X	X	X	X	X	X	X
		Resistive Touchscreen	X		O	X			X	X	X	X	X	X	X
		Optical Technologies (e.g. FTIR)	X	O	O	X			X	X	X	X	X	X	X
		Surface Acoustic Wave	X	X	O	X	X		X	X	X	X	X	X	X
		…													
	Freehand Gesture (3D)	Camera	O	O	O	O	**N**		O	O	O	O	O	O	O
		Distance Sensor		O	O		**N**		O	X	X	X	O		
		Accelerometer	O	O	O					X	X	X			
		Marker	O	O	O	O	O		O	O	X	X	O	O	O
		…													
	Haptics	Button	O	O	O					X		X	X	X	X
		Knob		O	O					X		X	X	X	X
		Switch	O	O	O					X		X	X	X	X
		Pedal	X	X	X		O	O	X	X	X	X	X	X	X
		…													

Fig. 1. Matrix for decomposing existing input forms for recombining them to new ones. While "O" mark existing and "X" mark not reasonable interaction forms, all blank field leave space for possible novel interaction forms, as the one used in the example marked with "N".

While several combinations already exist and others don't make sense, various "white fields" remain that could serve as inspiration for new interaction forms as the following example shows. Within figure 1, blank fields were identified in the combinations of foot movement and freehand gesture recognition via cameras or distance sensors. One idea that came up within the search for the applications of this novel interaction form was using the movement the right foot is doing before breaking. Employing this "gesture" for pre-tensioning the breaking system and preparing the car for the breaking maneuver accordingly to the speed of the foot movement could help reduce reaction time and thus contribute to safety.

4 Concluding remarks

Within this contribution, a theoretical approach was suggested that employs the design principles of abstraction, decomposition and (re)combination of partial solutions for generating new interaction forms by (re)combining human and technological partial solutions.

Practical application as well as interdisciplinary discussion of practitioners is now required to elaborate in how far this idea will work in practice. Doing this, three main aspects need to be addressed:

1. Does decomposition and (re)combination of existing interaction forms really lead to ne new interaction forms?
2. Are these new interaction forms applicable in automobile industry?
3. Do these new interaction forms have the potential to bring UX (back) to using a car (as driver, co-driver or passenger)?

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